# University of Minnesota Nano Fabrication Center
## Standard Operating Procedure

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|---|---|---|---|
| **Equipment Name:** | ALD | | |
| **Badger Name:** | PEALD | **Revision Number:** | 1 |
| **Model:** | FIJI | **Revisionist**: | T. Whipple |
| **Location:** | Bay3 PAN | **Date:** | 8/17/2015 |

### 1 Description

The PEALD is a Plasma Enhanced Atomic Layer Deposition system in the FIJI series from UltraTech/Cambridge Nano Tech inc, deposits thin films. This is done by cycling individual precursors for a short amount of time. Then another precursor is cycled. These precursors are alternated to build up a film. The more alternating cycles, or loops that are ran the thicker the resulting film will be. The steps to control the ALD system are very few. It is an easy machine to run.

### 2 Safety

a The system uses several gases, and of the gases are a pyrophoric gas. Pyrophoric means it will burn if exposed to air.

b The system uses electrical power and is under vacuum, so be aware these items. There should be **no** odor whatsoever. If you smell an odor, put system in STANDBY, and leave the area and Contact staff

c As the system is being heated the chamber and other parts can very hot so be careful while around the system, do not burn yourself.

d Do not edit the recipe beyond the number of cycles. Do not save the recipe.

e The system does have RF for generating a plasma, beware of this RF power.

### 3 Restrictions/Requirements

a Must be a qualified user on the PEALD.

### 4 Required Facilities

a Compressed air
b Nitrogen
c Argon
d Hydrgen
e House Exhaust

### 5 Definitions

a Precursor – A gas or liquid that is one of the building compounds to make a layer.
b Load lock – the loading chamber to load and unload wafers from the system.
b Recipe – Is the controlling software that makes the process of depositing a film.

## 6 Operating Instructions

a LOGGING ON

1. Check Badger for other reservations for the “PEALD” system first.
2. Enable "PEALD" on Badger.

b SETUP PROCEDURE

1. The ald system should have been left in a Standby mode with an **Idle** recipe running when it is not in use. Select the operating temperature you want to run at by selecting the correct Idle recipe, and this will set the temperatures to run at the correct operating value. Select the **Idle_xxx** recipe and run it.

Fig 1. Main items of the Fiji ALD system.

2. If the temperature is different than the current temperature the system will take a long time to change. And if going for a lower temperature it will take a very long time you should plan for this.

3. Once the system is at the correct temperature then you can load the wafer and select the deposition recipe and run it. The next section will explain how to load a wafer and get the system temperature set. The reason for loading the wafer into the load lock first is to get under vacuum and allow it to degas while the temperature is moving to the setpoint.

A LOADING WAFER INTO LOADLOCK

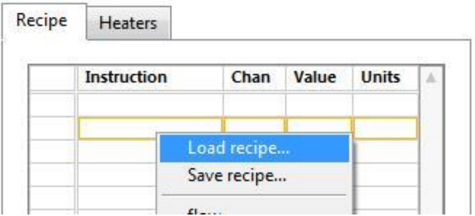
1. Loading the wafer into the loadlock awhile before moving it into the chamber is a recommended step from the ALD manufacture. Allowing the wafer to sit in the loadlock helps remove water vapor, which helps in making a better film. Removing moisture from the wafer is good and will help in having repeatable results.
2. Vent the Load lock this is done by pressing the [Vent Load Lock] button. You can tell if the load lock is done venting by looking at the space between the lid and the base, if there is a gap it is vented. Time takes 2 min.

Fig 2. Vented load lock and wafer is in the correct position.

3. Load the wafer in the load lock and position the wafer in the center of the substrate holder. Glass slides can be used to help keep the wafer in place. Using new slides is fine, but make sure that they are cleaned before using them, a solvent rinse and dry is all that is needed. Make sure the lid and O-ring are clean and close lid.
4. Pump down the load lock by pressing the [Pump Load Lock] button
5. There will be a sound that it made during the pumping step. If the sounds goes longer than 15 seconds without going silent, stop the venting and try again.

B SETTING OPERATING TEMPERATURE

1. Select the temperature you want the process to run at and load the IDLE recipe for that. Right click in the array area to have the menu open up click on the top line – Load recipe - Load recipe... To right click on the touch screen is to touch one area and stay there, after 3 seconds the screen will respond as if a right click was done.




2. Press the Start Recipe button to start the process running.

3. After the temperature of the chamber has been reached or close to it, now stop the current recipe by pressing the Stop Recipe button, then select yes.

4. If the time for the temperature change is needed you can log out of Badger while waiting, but make sure you have a reservation for the system during that time. Make sure you reserve the whole time you need. You will not be charged for any reservation on this system. Also include your desired running temperature when you make the reservation so a previous user can leave have the correct IDLE recipe set for you.

C SELECTING THE DEPOSITION FILM and STARTING

1. Open the chamber gate by pressing the Open Gate button.
2. Move the wafer from the load lock by pressing the Load Sample button. This will move it into the process chamber. Watch for transfer complete notice on top part of the screen. Look into the lid window to make sure the wafer is in the chamber.

5. After the wafer is loaded press the Close Gate button.

6. Select the recipe for the film that you want by selecting Load recipe... . Select the number of cycles that you want the process to run by selecting the last line in the recipe GOTO step for number of loops needed.

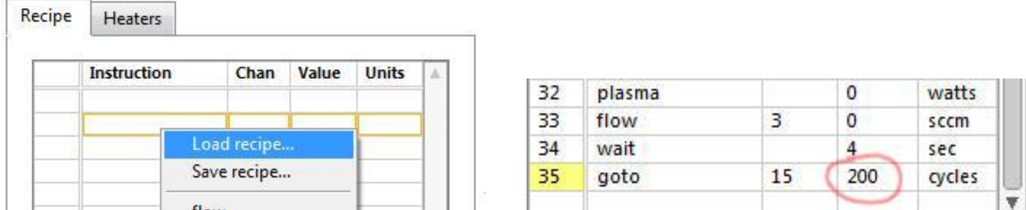



Fig 3. Loading recipe and adjusting the GOTO step for number of cycles.

9. For some films it is best to have a longer time before deposition, this helps in improving the film quality. Contact MNC staff in how to make this work.

Fig. 2. Notice the repeating wave forms, switching between a higher and lower peak.

4 It best to monitor the process from time to time. Making sure the graph looks correct and the temperature of the heaters are at the correct settings.

5 The amount of time left of the process can be checked by looking at the section labeled **Est. Time Remaining** and above that three time options can selected: **Est. Finish Time remaining** displays when the run will be completed.

6 The text on the top line will say process is complete. When the recipe is done.

C UNLOADING THE COMPLETED WAFER.

1. Open the chamber gate by pressing the [Open Gate] button.

2. Move the wafer from the load lock by pressing the [Unload Sample] button. This will move it into the process chamber. Watch for transfer complete notice on top part of the screen. Look into the lid window to make sure the wafer is in the chamber.

3. Press the close gate by pressing the [Close Gate] button.

4. Vent the Load lock this is done by pressing the [Vent Load Lock] button. You can tell if the load lock is done venting by looking at the space between the lid and the base, if there is a gap it is vented. Time takes 2 min, do not open before the time is done.

5. For higher temperature runs allow the wafer to cool while in the load lock, so the wafer surface does not react with the air in the cleanroom.

6. Load the IDLE recipe with the correct value for the future temperature to be ran. Check Badger to see the temperature listed in the next reservation. Run the recipe by pressing the Start Recipe button to start the process.

7. The START button will change and it will then display ABORT.

8. Log out of Badger.

**WARNING:**

DO NOT EVER **REMOVE** any precursors from the system.
DO NOT PRESS **ABORT** unless there is a problem with the system.
DO NOT EVER **EDIT** a recipe other than the GOTO step.
DO NOT process any wafers that have been in the PEALD in Bay 1 Keller wet benches
DO NOT touch the screen with anything else than the stylus.

## 7 Problems and Solutions

1. The chamber did not vent.

   Check that the normal status of the screen options are correct.
   Is the program running, the top button display " **Running** " ?

2. The normal program is not displayed. How can this be started.
   Contact MNC staff person

3. The system was shutdown, what can be done?
   Contact MNC staff person

4. The precursor is empty, now what?
   Contact MNC staff person

5. The deposit rate is much different than expected.
   Measure the film on another system, check refractive index of the film too. Confirm that the substrate is normal and have had known results. Set the time the graph displays to allow viewing of the whole run, anything changes seen?

6. The system was shutdown, what can be done?
   Contact MNC staff person

## 8 Appendix

Precursors used in the ALD system:

for Hafnium based films = Tetrakis(dimethylamino)hafnium **TDMAH** precursor at 75C

for Alumina based films = trimethylaluminum **TMA** precursor at room temp

for Titanium based films = tetrakis-dimethylamido-titanium **TDMAT** precursor at 75C

Gasses that are used in the ALD system are: O2, Ar, N2

*Common issues to be aware of with the ALD system..*

Make sure to include a bare Si sample to measure added thickness from ALD. Best to premeasure the Bare Si wafer using ellipsometer program ' thintest ' normal is 30Ang.

Lower temperatures process will have a higher deposition rate, see chart. The film quality and step coverage will be reduced, the exact amount has not been measured.

This tool is a second Generation of that tool set from UltraTech/Cambridge Nano Tech, inc. called FIJU G2

<u>To help in making the PEALD system easier to use we are try out something new.</u>

We will NOT charge for any reservation to run the tool. This is to allow users to reserve time for the whole time they will need the system, this includes the time needed to change the temperature.

BUT you need to first do a few things correctly.

1: Set your time you need for the reservation in Badger, including the time needed for the temperature change.

2: When you run the PEALD system you need to log in to Badger as normal and then if the temperature needs to change run the correct recipe. Log out of Badger when the temperature is adjusting, and put the " Temperature change in progress " sign in front of the monitor.

3: After the temperature has reached its setpoint log back into Badger ( remove sign ) and run the process as normal. When you are done check on Badger to see if another person has a reservation after you in the near future, if so check and see if they recorded the temperature they will be running at. If so select and run the 'Idle_xxx' for the temperature they need.

Notice - this procedure might change in the future.